Remeasurement of some of the Stars of the above Catalogue.

Stars South of θ Orionis.			Stars South (*continued*).		
h. 17	preceding	702·7 / 42·8	h. 54	preceding	85·7 / 175·1
18		683·7 / 244·1	62		39 / 449·3
26		536·2 / 207·6	88	following	66·7 / 24·4
27		543·3 / 71·8	91		112·8 / 53·8
33		463·3 / 113·6	93		96·3 / 93·2
36		382·7 / 50·6	95		113·9 / 440·5
37		355·3 / 583·3	103		150·1 / 248·1
40		317·2 / 420·9	101		151·5 / 97·2
41		270·6 / 36	104		178·7 / 170·5
43		290·5 / 483·4	111		227·1 / 579·1
45		241·8 / 117·9	112		239·6 / 457
47		192·6 / 397·8	117		359·5 / 213·2
50		163·6 / 116·7	123		380·4 / 284·4
52		105·5 / 398·3	126		412·6 / 503·5
53		91·4 / 273·1	133		507·1 / 301·7
51	preceding	84·2 / 21·8	142	following	783·6 / 254·9

Stars North of θ Orionis.			Stars North (*continued*).		
h. 12	preceding	776·8 / 70·5	h. 86	following	63·4 / 669·0
19		639·9 / 10·2	87		61·1 / 99·8
32		492·8 / 286·4	99		148·8 / 611·2
35		400·2 / 270·4	102		144·6 / 488·0
38		304·0 / 0·0	109		214·4 / 272·8
44		246·8 / 8·6	108		210·7 / 440·3
48		172·9 / 502·1	113		277·7 / 658·9
49		161·2 / 663 9	120		367·3 / 195·3
56	preceding	86·1 / 380·4	124		384·8 / 584·7
70	following	9·0 / 96·6	129		459·0 / 387·9
75		24·1 / 41·5	136		625·5 / 65·7
76		32·2 / 166·3	137	following	666·1 / 363·9
79	following	21·0 / 400·4			

April 30, 1868.

Lieut.-General SABINE, President, in the Chair.

The following communications were read:—

I. "Observations on the Development of the Semilunar Valves of the Aorta and Pulmonary Artery of the Heart of the Chick." By MORRIS TONGE, M.A., M.D. Communicated by Dr. BEALE. Received March 24, 1868.

(Abstract.)

Kölliker is the only embryological author in whom I have found any information about the development of the semilunar valves of the aorta and

pulmonary artery, and I have not been able to discover any observations later than his. After speaking of the formation of the aorta and pulmonary artery by the division of the *truncus arteriosus* into two vessels, this being, as is well known, the large single arterial trunk conveying the blood from the rudimentary ventricle into the branchial arteries, he says*, "Simultaneously with the division the semilunar valves also become developed, and I saw them already present in both arteries in an embryo of the seventh week. They are, however, at first nothing but horizontally projecting crescentic growths of the middle and of the epithelial coats by which the *lumen* † at this spot receives the form of a three-rayed star. At what time they first become visible as distinct pockets I have not yet investigated."

The division of the *truncus arteriosus* is described by Rathke as occurring in birds and mammalia by the formation on its interior of two oppositely situated longitudinal ridges, which then grow together throughout its whole extent and completely divide the vessel into two lateral halves, one representing the commencement of the aorta, and the other that of the pulmonary artery. Though the semilunar valves are said by Kölliker, and quite correctly, to develope simultaneously with the division, he gives no information about the manner in which they are connected with it, or the part of the vessel in which they originate, and nowhere are any drawings given of them in their rudimentary state. I was hence led to conclude that very little was known about this point, and to make the observations the results of which are here recorded. They seem to me valuable, as throwing light on some of the congenital malformations of this part of the heart. They were made during 1865, 1866, and 1867, on the embryos of the common fowl, and I have had no opportunity of investigating human or other mammalian embryos with reference to this point. But from the great likeness between the hearts of birds, mammalia, and man at different periods of their development, it seems pretty certain that the arterial semilunar valves in man and mammalia generally must pass through the same stages of development as those of the bird, which, in the fully developed state, quite resemble them.

The eggs were incubated by artificial heat, and the hearts of more than fifty embryos, at various stages of development, were examined. The embryos were prepared by immersing them, immediately on their removal from the egg, in strong alcohol. By this the large vessels were obtained distended with blood and hardened. They were afterwards rendered transparent by soaking them in strong glycerine, in which they were dissected

* Kölliker, 'Entwickelungsgeschichte des Menschen,' pp. 404, 405 (1861).

† I have left this word untranslated because no single English word exactly expresses its meaning. It is obviously the bright area of the interior of a transverse section of the vessel held up to the light. The boundary of the bright area shows the form of the vascular canal at this point.

and examined by strong transmitted light, and were afterwards mounted in glycerine jelly.

The new facts observed demonstrate—

(1) The manner in which the *truncus arteriosus* divides into two vessels, which is different from that commonly supposed to occur.

(2) The close connexion between this process of division, and the formation of the semilunar valves of the aorta and pulmonary artery, and their place of origin and mode of development.

The following is a brief account of the manner in which the division of the *truncus arteriosus* takes place. It should be said that about the third day of incubation, just before the division begins, the somewhat spirally twisted truncus arteriosus is everywhere smooth, and free from ridges on its interior, and ends abruptly in the three pairs of branchial arteries which then exist. These are the third, fourth, and fifth pair. There is no valvular apparatus at its branchial end, but next the ventricle the deficiency of valves seems to be supplied by a considerable development of the elastic wall of the truncus arteriosus on its two opposite sides, so that the ventricular aperture, which is at first circular, becomes slit-shaped. The two lips of the slit seem to prevent in great measure the reflux of blood into the ventricle, before the semilunar valves are sufficiently developed to do so.

The division of the vessel commences about the 106th hour of incubation, at rather less than one-fifth of the whole period of incubation, which is 21 days.

It begins at the branchial end of the truncus arteriosus by the extension into it of a plane septum growing horizontally downwards into the vessel from the terminal arterial wall between the openings of the fourth and fifth pair of branchial arteries. Its lower margin is forked, so that it extends further along the sides than along the centre of the vessel, and it is inclined a little obliquely across the vessel, sloping downwards from left to right. The little channel in front of this septum leads to the third and fourth pair of branchial arteries, and is the rudimentary aorta; the channel behind it leads to the fifth pair of branchial arteries, and is the rudimentary pulmonary artery.

At the same time, or slightly before this, the canal of the vessel just below the septum becomes constricted by the formation—

(1) On its anterior and left surface, of two flattened prominences, separated by a groove. These are the rudiments of the anterior semilunar valve of each artery.

(2) On its anterior and right surface, of a flattened ridge, extending obliquely across the vessel nearly opposite to the anterior valve rudiments, afterwards becoming prominent and pyramidal in the centre, and extending gradually down the posterior surface of the vessel. The right and left ends of this ridge are the rudiments of the inner semilunar valves of each artery. As these growths enlarge, the forked septum grows downwards into the

artery, twisting gradually from left to right, its left leg passing between and separating the anterior semilunar valve rudiments, and its right leg growing into the central portion of the oblique ridge on the posterior surface, now becoming prominent and pyramidal, and separating from each other the rudiments of the inner valves. Between the outer and inner semilunar valves in each artery there is a vacant space left on the wall of the vessel, from which the outer semilunar valve in each artery afterwards grows out, the outer valves appearing later than the others. The division of the truncus arteriosus proceeds by the gradual growth downwards of the forked septum along the course of the ridge on the posterior surface, which gradually becomes more prominent, the right leg of the fork, which proceeds along it, being always a little in advance of the other. The anterior or left leg of the fork corresponds with the right margin of the anterior aortic valve, and terminates almost immediately on the anterior surface, no ridge being formed along the anterior surface as there is along the posterior. As the forked septum between the aorta and pulmonary artery grows down the vessel, the semilunar valves gradually become more developed, and the rudiments of the outer valves appear. They appear soon after the 117th hour of incubation, by which time the aorta and pulmonary artery are separated for some little distance.

During these changes the aperture into the ventricle has become a rectangular slit, passing horizontally backwards and to the right, and having a left-hand and a right-hand lip, the left-hand lip sloping from before backwards and upwards into the artery, and joining the lower end of the ridge that has been gradually forming on the posterior surface of the vessel. As the division proceeds the ends of each lip of the ventricular slit disappear, and the central portions, especially of the left-hand lip, become more prominent. By this a channel is left in front and towards the left, and behind and to the right. By the time the division has descended to the ventricular aperture, the original right-hand leg of the forked septum has wound round to the centre of the left-hand lip of the slit, the left-hand leg to the centre of the right-hand lip, so that the aortic channel has passed from front to back, and the pulmonary channel from back to front, the anterior portion of the ventricular slit thus becoming the root of the pulmonary artery, and the posterior portion the root of the aorta.

The septum of the ventricles has been gradually forming during the process of division of the truncus arteriosus, and by the time the division and valves have descended nearly to the base of the ventricles, there remains merely an oval aperture in the upper portion uniting the ventricular cavities. It forms a short canal with a left ventricular border and a right ventricular border. The arterial infundibula are finally separated from each other by the union of the lower half of this right ventricular border with the lower border of the forked arterial septum. The anterior portion of the right ventricular border is continued upwards and forwards into the

termination of the original right leg of the fork in the central part of the left-hand lip of the ventricular slit, while the posterior portion passes off slantingly upwards and forwards as a ridge, which forms the termination of the original left leg of the fork in the central part of the right-hand lip of the slit. Thus a twisted, hourglass-shaped aperture connects the arterial infundibula, by whose closure the pulmonary infundibulum and root of the pulmonary artery become separated from the root of the aorta and the canal of the aperture in the septum, which then becomes the aortic infundibulum. This process is completed about the end of the eighth day. The separation of the vessels does not become visible externally till it has advanced a considerable distance down the truncus arteriosus, and the semilunar valves are considerably developed.

The division of the truncus arteriosus into the aorta and pulmonary artery does not therefore take place by the formation of *two* oppositely situated longitudinal ridges, and their subsequent growth together, but occurs, as above described, by the extension into it of a plane septum from between the fourth and fifth pair of branchial arteries, and which twists down the vessel along the line of a single thick pyramidal ridge which forms gradually on its posterior aspect.

The formation of the semilunar valves is very closely connected with the process of division of the *truncus arteriosus*, and the following are the new facts arrived at with respect to their origin and development :—

1. It is a remarkable fact that the rudiments of the semilunar valves first appear on the interior of the truncus arteriosus *at a considerable distance from the heart*, near the termination of the truncus arteriosus in the branchial arteries, and not near the heart, as one might have been led to expect.

2. It is also very remarkable that the rudiments of the anterior and inner semilunar valves of each artery make their appearance before the partition, which has already begun to separate the aorta from the pulmonary artery, has quite descended to that part of the truncus arteriosus in which these valves originate.

3. The rudiments of the anterior semilunar valves of the aorta and pulmonary artery are the first to appear, those of the inner valve of each artery the next, and those of the outer valves the last. The development of the last valve to appear remains behind that of the others throughout.

4. The anterior valve-rudiments appear close together, rather on the right side of the anterior surface of the truncus arteriosus, about the 106th hour of incubation, simultaneously with the commencement of the division, and a short distance below it, and opposite the commencement of the ridge which forms on the posterior surface of the vessel, and which appears about the same time.

5. The rudiment of the inner valve of each artery grows from the

corresponding side of the ridge which forms gradually on the posterior surface of the vessel, a little later than the anterior valves.

6. The rudiment of the outer valve in each artery arises from that part of the inside of the wall of the truncus arteriosus left vacant between the outer margins of the rudiments of the anterior and inner valves soon after the 117th hour of incubation. It arises level with the other valves, when the aorta and pulmonary artery are already separated from each other for some little distance, and therefore a little nearer to the heart than the other valves, though still at a considerable distance from it.

7. The anterior valve-rudiments commence as transverse thickenings of the interior of the vessel, sloping off above and below into the general surface of the vessel, and are separated by a slight groove.

8. The inner and outer valves first appear as simple pyramidal thickenings of the vascular wall.

9. All the semilunar valves are solid at first.

10. The anterior and inner valves consist of one single segment for each valve.

11. The outer valve is at first a single pyramidal eminence. It may remain single, or become deeply notched and develope into two valves, or even more.

12. By the time the third valve in each vessel has appeared, the form of the valves has become more defined. They then have the shape of a short crystal of triple phosphate  , its flat surface being attached, its edge projecting into the vessel, and its ends sloping off upwards and outwards above, and downwards and outwards below. The valves are more developed in the direction of their length than transversely, and their course down the wall of the vessel is parallel to that which the axis of its canal afterwards assumes.

13. About the 144th hour of incubation they are (though still solid and at some distance from the heart) sufficiently developed to close the canal of the vessel pretty completely, and to prevent much reflux of blood into its undivided portion.

14. By this time the valvular function of the two lips of the opening into the ventricle has become abolished.

15. The valves are further developed by the hollowing out of the solid pyramid above and near the wall of the vessel, while they grow in other directions.

16. The pocketing of each valve commences in each in the order of its appearance, and begins in the anterior and inner valves of each artery about the time that their bases have descended to the level of the bases of the ventricles, *i. e.* at the 147th hour of incubation, and is distinct in these valves at the 165th hour. The pocketing of the outer valves is not distinct till much later. About the time that it commences, the valves

have assumed nearly their final positions with respect to the base of the heart, and the aperture of communication between the arterial infundibula is nearly closed up.

17. After the complete separation of the aortic and pulmonary infundibula from each other, the further changes in the semilunar valves consist principally in increase in size and diminution in thickness, so that they become more and more membranous, *pari passu*, with the growth of the other parts of the heart.

In the description given above of the division of the truncus arteriosus, it has been shown that the aperture in the septum of the ventricles does not close up entirely as is commonly supposed, but finally developes into the aortic infundibula.

The fifth vascular arch on each side gives off the branch to the lung of that side, and becomes ultimately the corresponding branch of the pulmonary artery, according to the view long ago propounded by Von Baer.

In conclusion I must thank several kind friends for assistance received from them during the preparation of this paper, which I here beg leave to acknowledge. In particular Dr. Beale, who has given me much valuable advice throughout; the Rev. George Kempson and my cousin Mr. Charles Paddison, who sent me abundant supplies of fresh eggs; and Dr. Cayley, who kindly revised the translations from the German authors referred to.

II. "On the Phenomena observed to attend the propulsion of Lymph from one of the Lymphatic Hearts into a Vein in the Frog." By Thomas Wharton Jones, F.R.S., Professor of Ophthalmic Medicine and Surgery in University College, &c. Received March 28, 1868.

(Abstract.)

An anæmic frog, killed, as regards sensation and voluntary motion, without stoppage of the circulation, by plunging into water at 110° or 120° Fahr., was laid open, and the posterior part of the anterior lymphatic heart of one side, in the niche behind and below the extremity of the large transverse process of the third vertebra, brought into view. By the removal of the skin of the back from over the scapular region, the part of the heart mentioned admitted of examination by transmitted light under a simple microscope—the lens $\frac{1}{2}$-inch focus. It was seen that when the lymphatic heart contracted, a stream of lymph was propelled from it into a vein at its posterior border, and swept before it the blood in that vessel, whilst the flow from behind was arrested. As soon, however, as diastole of the lymphatic heart supervened, the flow of blood from behind became re-